HAPTIC FEEDBACK FOR BUTTON AND SCROLLING ACTION SIMULATION IN TOUCH INPUT DEVICES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/616,648 filed Oct. 8, 2004 in the name of the same inventors and commonly assigned herewith.

[0002] This application may be considered to be related to the following prior patents and patent applications: U.S. patent application Ser. No. 10/615,986, filed Jul. 10, 2003, which is, in turn, a continuation of U.S. patent application Ser. No. 10/213,940, filed Aug. 6, 2002, which is, in turn, a continuation of U.S. patent application Ser. No. 09/487,737, filed Jan. 19, 2000, now U.S. Pat. No. 6,429,846, which is, in turn, a continuation-in-part of U.S. patent application Ser. No. 09/467,309, filed Dec. 17, 1999, now U.S. Pat. No. 6,563,487, which is, in turn, a continuation-in-part of U.S. patent application Ser. No. 09/156,802, filed Sep. 17, 1998, now U.S. Pat. No. 6,184,868, which is, in turn, a continuation-in-part of U.S. patent application Ser. No. 09/103,281, filed Jun. 23, 1998, now U.S. Pat. No. 6,088,019, which is, in turn, a continuation-in-part of U.S. patent application Ser. No. 09/253,132, filed Feb. 18, 1999, now U.S. Pat. No. 6,243,078, all commonly assigned herewith. This application may also be considered to be related to U.S. patent application Ser. No. 09/917,263, filed Jul. 26, 2001, now U.S. Pat. No. 6,822,635 (based on U.S. Provisional Patent Application Ser. No. 60/274,444, filed Mar. 9, 2001); U.S. patent application Ser. No. 10/213,354, filed Aug. 5, 2002, now abandoned; U.S. patent application Ser. No. 10/919,648, filed Aug. 17, 2004, now pending; U.S. patent application Ser. No. 10/919,798, filed Aug. 17, 2004, now pending; PCT/US01/01486, filed Jan. 17, 2001; and PCT/US02/17102, filed Mar. 8, 2002. All of the foregoing United States patents and applications are hereby incorporated herein by reference as if set forth fully herein.

BACKGROUND OF THE INVENTION

[0003] The present invention relates generally to the interfacing with computer and mechanical devices by a user, and more particularly to devices used to interface with computer systems and electronic devices and which provide haptic feedback to the user.

[0004] Humans interface with electronic and mechanical devices in a variety of applications, and the need for a more natural, easy-to-use, and informative interface is a constant concern. In the context of the present invention, humans interface with computer devices for a variety of applications. One such application is interacting with computer-generated environments such as are found in, for example, games, simulations, and application programs.

[0005] In some interface devices, force feedback or tactile feedback is also provided to the user, collectively known herein as "haptic feedback." For example, haptic versions of joysticks, mice, game pads, steering wheels, or other types of devices can output forces to the user based on events or interactions occurring within the computer-generated environment, such as a graphical environment found in a game, simulation or other application program.

[0006] In portable computer or electronic devices, such as laptop computers, moveable mouse-type position encoding input device often require too large a workspace to be practical. As a result, more compact devices such as trackballs are often used. A more popular device for portable computers are "touchpads," which are usually embodied as small rectangular, planar pads provided near the keyboard of the computer. Touchscreens are also used and becoming more popular. Touchpads do not incorporate an integral display device—touchscreens do. Such touch input devices sense the location of a pointing object (such as a user's finger or an input stylus) by any of a variety of sensing technologies, such as capacitive sensors, infrared light beams, pressure sensors that detect pressure applied to the touch input device, and the like. In a common application the user contacts the touch input device with a fingertip and moves his or her finger on the surface of the control to move a cursor displayed in the graphical environment or to select a displayed element. In other applications, a stylus may be used instead of a finger.

[0007] One problem with existing touch input devices is that there is no haptic feedback provided to the user. The user of a touchpad is therefore not able to experience haptic sensations that assist and inform the user of targeting and other control tasks within the graphical environment. The touch input devices of the prior art also cannot take advantage of existing haptic-enabled software run on the portable computer.

SUMMARY OF THE INVENTION

[0008] The present invention is directed to a haptic feedback planar touch input device used to provide input to a computer system. The touch input device can be a touchpad provided on a portable computer, or it can be a touch screen found on a variety of devices, or it may be implemented with similar input devices. The haptic sensations output on the touch input device enhance interactions and manipulations in a displayed graphical environment or when using the touch input device to control an electronic device.

[0009] More specifically, the present invention relates to a haptic feedback touch input device for inputting signals to a computer and for outputting forces to a user of the touch input device. The touch input device includes an approximately planar (planar or near-planar) touch surface operative to input a position signal to a processor of said computer based on a location of user contact on the touch surface. The position signal may be used in a number of ways, for example, it may be used to position a cursor in a graphical environment displayed on a display device based at least in part on the position signal. It may be used to rotate, reposition, enlarge and/or shrink an image of an object displayed on a display device based at least in part on the position signal. It may be used to provide other desired inputs to a computing device. These inputs may include scroll-inputs causing text or displayed images to move up, down, right or left, to rotate, or to be made larger or smaller in the graphical environment. At least one actuator is also coupled to the touch input device and outputs a force on the touch input device to provide a haptic sensation to the user contacting the touch surface. The actuator outputs the force based on force information output by the processor to the actuator. Most touch input devices also will include an ability to measure the relative pressure applied to the touch